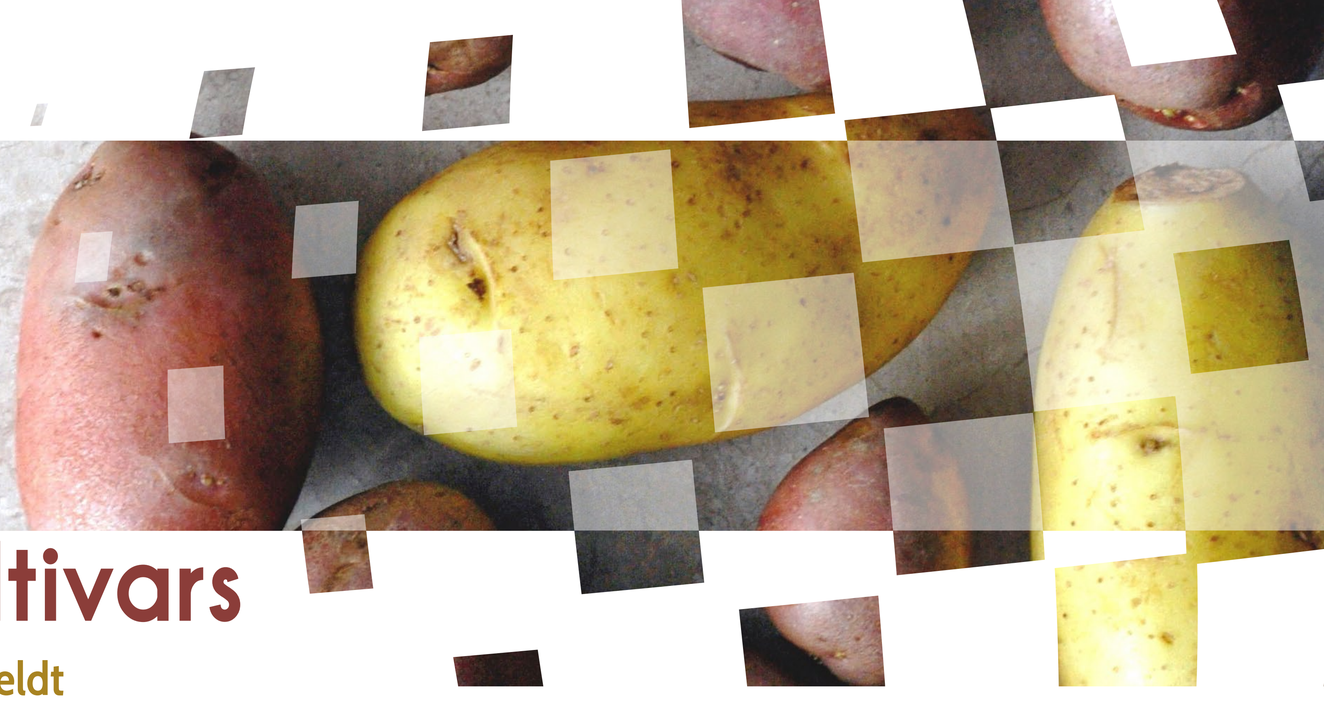
Determining the *amino acid content* of four popular South African potato cultivars



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Introduction

Protein is considered an important macronutrient in the diet as it provides both essential amino acids and is a source of energy. Plant sources of protein can make a significant contribute to protein intake of vulnerable individuals especially in countries where high quality proteins from animal source foods is scarce. Proteins play a major structural role in the human body and are essential building blocks for muscles, encouraging tissue repair and development. Protein must be consumed in adequate amounts in order to achieve optimum nutritional status.

According to the Food and Agricultural Organisation (FAO) when evaluating dietary protein *"dietary amino acids should be treated as individual nutrients and wherever possible data for digestible or bioavailable amino acids should be given in food tables on an individual amino acid basis"* (FAO, 2013). The metabolic effect of specific individual dietary amino acids is of interest, calling for accurate information on the amino acid profile of foods.

To meet the growing need for alternative sources of high quality proteins research on various supplementary crops are encouraged that reflect the true and total nutritional effect of food protein. Potatoes are the most important non-cereal food crop with global production figures reaching 330 million tons (FAO, 2018). Besides being a concentrated source of carbohydrates potatoes also contain other macro- and micronutrients that can contribute to human and dietary health.

Aim

The aim of the study was to determine the amino acid profile of four different potato cultivars commonly consumed in South Africa. Furthermore, the protein quality scores were calculated.

Materials and methods

Sampling of potatoes was conducted during October – December 2018. Four cultivars that contribute to the largest market share, as shown in brackets, in South Africa were chosen for this study. Mondial (55%) and Sifra (23%) were sourced from three different production regions in South Africa i.e. Free State, Limpopo and Sandveld, and were analysed as two composite samples respectively. The other cultivars Valor (6%) and BP1 (2%), were sourced from Limpopo as this was the region that was harvesting at the time of the study. All tubers were cultivated according to common agricultural practices of each specific to each region. Three tubers were selected from each cultivar and analysed as a composite sample.

Analyses

Determining protein

Total nitrogen was determined using the accredited Kjeldahl method (AOAC 991.20). The nitrogen content was then used to calculate crude protein using the Jones conversion factor of 6.25 (Greenfield & Southgate, 2003).

Determining amino acids and protein quality scores

The amino acid profile was determined using High Performance Liquid Chromatography (HPLC) with flourescence detection. Specific amino acids were determined according to the accredited methods stated in Table 1. Calculations used for further scores are shown in Table 2.

Table 1: Analyses used for amino acid determination

Amino acid	Reference
Arginine, hydroxyproline, serine, aspartic acid, glutamic acid, threonine, glycine, alanine, tyrosine, proline, methionine, valine, phenylalanine, isoleucine, leucine, histidine and lysine	(Einarsson, et al., 1983)
Cysteine	(Gehrke, et al., 1985)
Tryptophan	(De Vries, et al., 1980)

Table 2: Calculations used to determine essential amino acid index, protein digestibility corrected score and digestible indispensable amino acids score and statistical calculations

Calculation	Reference
Essential amino acid index (EAAI)	(Abdualrahman, et al., 2019)
Protein digestibility corrected amino acid score (PDCAAS)	(FAO/WHO, 1991)
Digestible indispensable amino acid score (DIAAS)	(Moughan & Rutherfurd, 2011)
One-way analysis of variance (ANOVA)	(Payne, et al., 2012)

Results and discussion

The protein and amino acid content of the analysed tubers are presented in Table 3 as g/100g product. Protein values did not differ significantly (p=0.055) between the various tubers, ranging from the lowest value for Valor (1.65g/100g) to the highest value for BP1 (2.14g/100g) (Figure 1). Of the nine essential amino acids (histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine) five differed significantly between the various cultivars. The values for methionine, tryptophan and glycine were similar. and therefore statistical analysis could not be conducted on them. Concentrations of histidine and lysine did not differ significantly between the different cultivars.

The Essential Amino Acid Index (EAAI) gives a stronger indication of potential nutritive value than individual amino acid values. The BP1 cultivar had the highest EAAI index followed by Valor, Mondial and Sifra.

There are numerous methods to assess the nutritional value of proteins. The Protein Digestibility - Corrected Amino Acid Score (PDCAAS), was adopted as the preferred method for measurement of the protein quality in human nutrition. However, the truncation of PDCAAS to 1.0 means that important information on highly nutritional proteins is discarded (Millward, 2012; FAO, 2013; Joye, 2019). A more recent protein quality score is the Digestible Indispensable Amino Acid Score (DIAAS), that compares the content of all digestible essential amino acids in a protein to the level of these digestible amino acids in a reference protein. Figure 2 shows digestible indispensable amino acid scores of the four cultivars. The DIAAS values ranged between 98.94 for Sifra and 113.89 for BP1.

Table 3: Protein, amino acid content and quality scores (IEAA, PDCAAS, DIAAS) of four cultivars

Analysis	P-value	Mondial	Sifra	Valor	BP1
Protein (N x 6,25)	p=0.055	1.77	1.94	1.65	2.14
Sum of amino acids		1.75	1.93	1.64	2.14
Essential amino acids		0.675	0.740	0.675	0.860
Arginine	p≥0.05	0.135^{a}	0.135^{a}	0.105^{b}	0.120^{ab}
Histidine	p=0.603	0.055	0.050	0.040	0.040
Isoleucine	p≥0.05	0.050^{c}	0.060^{b}	0.065^{b}	0.080^{a}
Leucine	p≥0.05	0.075^{c}	0.095^{b}	0.090^{bc}	0.115^{a}
Lysine	p=0.052	0.115	0.120	0.110	0.145
Methionine	*	0.030	0.030	0.030	0.040
Phenylalanine	p≥0.05	0.060^{b}	0.065^{b}	0.070^{b}	0.095^{a}
Threonine	p≥0.05	0.055^{c}	0.070^{b}	0.060^{c}	0.080^{a}
Tryptophan	*	0.020	0.020	0.020	0.030
Valine	p≥0.05	0.080^{b}	0.095^{b}	0.085^{b}	0.115^{a}
Non-essential amino acids		1.075	1.185	0.965	1.275
Alanine	p≥0.05	0.055^{c}	0.080^{a}	0.060^{c}	0.070b
Aspartic acid	p≥0.05	0.345^{b}	0.315^{b}	0.355^{b}	0.475^{a}
Cystine	p=0.258	0.025	0.025	0.020	0.040
Glutamic acid	p≥0.05	0.420^{b}	0.495^{a}	0.27^{c}	0.375^{b}
Glycine	*	0.050	0.050	0.050	0.060
Proline	p=0.4	0.055	0.075	0.080	0.080
Serine	p≥0.05	0.055^{c}	0.070^{b}	0.060^{c}	0.080^{a}
Tyrosine	p≥0.05	0.060^{b}	0.065^{b}	0.060^{b}	0.085^{a}
Methionine + Cystine	p=0.08	0.055	0.055	0.050	0.080
Phenylalanine +Tyrosine	p≥0.05	0.120^{b}	0.130^{b}	0.130^{b}	0.180^{a}
PDCAAS (using the faecal protein digestibility (90) of Branco-Pardal (1995))		1	1	1	1
DIAAS (using the faecal protein digestibility (90) of Branco-Pardal (1995))		101	98	108	114
Essential amino acids index IEAA		1.37	1.37	1.49	1.52
Essential amino acids index %		137	137	149	152

Values were too similar and no statistical analyses were possible

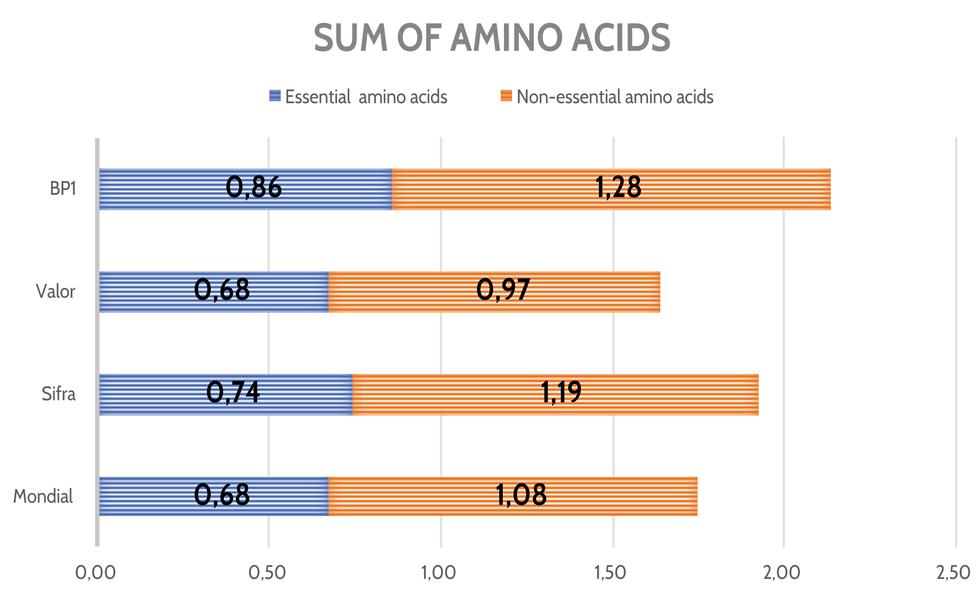

Figure 1: Sum of amino acids (g/100g product)

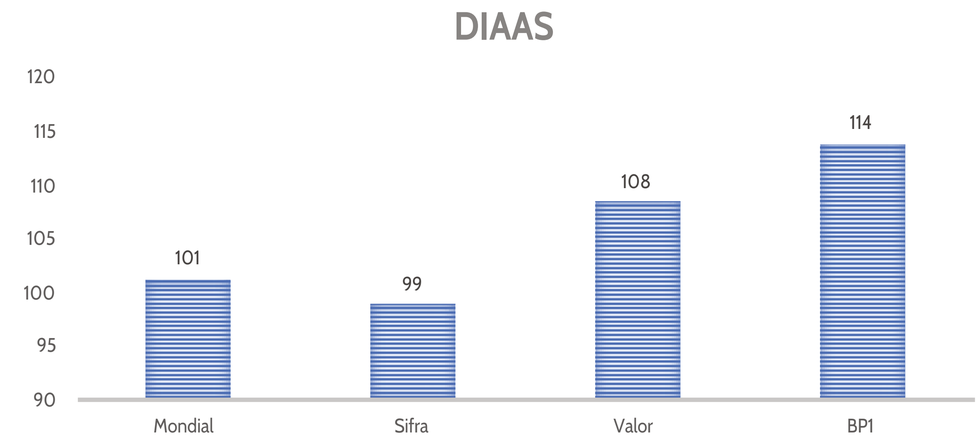

Figure 2: Digestible Indispensable Amino Acid Score (DIAAS) for the four potato cultivars

Conclusions

The agricultural landscape consists of a smorgasbord of climatic regions, practices, and unforeseen occurrences. This diverse agricultural landscape is further influenced by the ever changing and dynamic dietary backdrop of the country which has a bilateral effect of food production and consumption. All of these biotic and abiotic factors may have a significant effect on the internal characteristics and subsequently nutritional properties of a commodity which can have a direct influence on the dietary value. From this study it was found that there was no significant difference in the protein content of the four chosen potato cultivars. Although the protein content is low, potatoes contain high quality protein that can contribute to overall protein consumption in the diet.

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Acknowledgement
The authors acknowledge(s) funding from the Department of Science and Technology (DST)/National Research Foundation (NRF) South African Research Chairs Initiative (SARChI) in the National Development Plan Priority Area of Nutrition and Food Security (Unique number: SARCI170808259212). The grant holders acknowledge that opinions, findings and conclusions or recommendations expressed in any publication generated by the NRF-supported research are that of the author(s), and that the NRF accepts no liability whatsoever in this regard.